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November 13, 2000

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: Application of Kiyomi TAMAGAWA and Hirokazu KONDO
PROFILE PRODUCING METHOD AND PROFILE PRODUCING APPARATUS
Our Ref. Q61700

Dear Sir:

Attached hereto is the application identified above including sixty-six (66) sheets of the specification, claims, fourteen (14) sheets of formal drawings, two (2) priority documents, executed Assignment and PTO 1595 form, and executed Declaration and Power of Attorney. Also enclosed is the Information Disclosure Statement with references and PTO Form 1449.

The Government filing fee is calculated as follows:

Total claims	15	-	20	=		x	\$18.00	=	\$0.00
Independent claims	3	-	3	=		x	\$80.00	=	\$0.00
Base Fee									\$710.00
TOTAL FILING FEE									\$710.00
Recordation of Assignment									\$40.00
TOTAL FEE									\$750.00

Checks for the statutory filing fee of \$710.00 and Assignment recordation fee of \$40.00 are attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16 and 1.17 and any petitions for extension of time under 37 C.F.R. § 1.136 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A duplicate copy of this transmittal letter is attached.

Priority is claimed from November 11, 1999, based on JP Application Nos. 11-320680, and 11-320683. The priority documents are enclosed herewith.

Since the anniversary of the priority date fell on a Saturday, the filing of this application on November 13, 2000, is sufficient to obtain the benefit of priority.

Respectfully submitted,
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SPECIFICATION

PROFILE PRODUCING METHOD AND PROFILE PRODUCING APPARATUS

5 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a profile producing method and a profile producing apparatus for producing a profile representative of the association
10 between the colors on a color image and the color data in accordance with which the color image is outputted, in an output device such as a color printer and a printing machine for outputting color images in accordance with image data including color data.

15 Description of the Related Art

Hitherto, it is widely performed that a color image is outputted by an output device such as a color printer and a printing machine in accordance with, for example, image data obtained through reading an original
20 image by a color scanner and the like, and image data generated by a computer. At that time, when it is intended, for example, to output a color image which is very close in color to an original image before reading by a scanner, or to output a color image having a desired color
25 representation, it is an important problem as to what color is reproduced on the color image in accordance with color data included in image data fed to the output device for

outputting the color image. The association between the color data and the color on the color image outputted is referred to as a profile of the output device.

Fig. 19 is a flowchart useful for understanding the conventional method of producing a profile. Here, there will be explained, by way of example of the output device, a printing machine for printing a color image in accordance with image data including color data representative of dot% for four colors of cyan (C), magenta (M), yellow (Y) and black (K).

To produce the profile of the printing machine, for example, a computer is used to produce image data representative of a color chart consisting of a plurality of color patches associated with a plurality of sorts of color data obtained through sequentially varying dot% on each of four colors of C, M, Y, K (step e1 of Fig. 19), the image data thus produced are transmitted to the printing machine to print the color chart (step e2), and the printing machine produces a print sample of the color chart (step e3). Next, a plurality of color patches on the print sample of the color chart are subjected to a colorimetry by a colorimeter (step e4) to obtain the association (here, it is referred to as the "association M") between the color data transferred to the printing machine for output of the color chart and chromaticity values of XYZ values of XYZ color system determined by, for example, CIE, which chromaticity values are obtained

through measurement of the color chart (step e5).

The association M the color data and the chromaticity values is restricted in number of color patches constituting the color chart, and thus it is an association corresponding to the coordinate points rather rough and scattered on a color space. Therefore, such an association M is too rough to express the profile of the printing machine.

In view of the foregoing, in the next step e6, a table T representing the profile of the printing machine is produced in accordance with a computation (it is referred to as a "computation A") for producing a table including an interpolation arithmetic operation processing and the like.

As the computation A, it is possible to preferably adopt a computation scheme, for example, as proposed in Japanese Patent Application Laid Open Gazette Hei. 10-126633, that the association between the color data and the chromaticity values, which corresponds to each of sides on a three-dimensional shape (corresponding to a cub in case of a three-dimension) defining an external form of an area (a color reproducing area) to be expressed by the printing machine, on CMYK color space, is determined, then the association between the color data and the chromaticity values, which corresponds to coordinate points on each surface encircled by a plurality of sides, is determined, and finally, the association between the color data and the chromaticity values, which corresponds to coordinate points

inside the three-dimensional shape.

The use of the table (the profile) thus produced makes it possible to print a color image of a desired color representation using a printing machine.

5 To determine a profile of an output device through adoption of the above-mentioned method, there is a need to measure a color chart composed of a large number of color patches outputted from the output device. This is associated with such a problem that it takes a great deal of time. An adoption of the computation scheme, which is proposed in Japanese Patent Application Laid Open Gazette Hei. 10-126633, makes it possible to considerably reduce the number of color patches as compared with the earlier technology. However, even in the event that such a computation scheme is adopted, there is a need to output and measure hundreds of color patches in order to produce a table (a profile) excellent in precision.

As a method in which the above-mentioned problem is improved to allow the use of a small number of patches, Japanese Patent Application Laid Open Gazette Hei. 10-136219 proposes a technology that a table produced beforehand on a reference output condition is corrected in accordance with data obtained through colorimetry of a small number of color patches outputted on the correction output condition, so that a new table is produced.

However, according to the proposed technology in Japanese Patent Application Laid Open Gazette Hei. 10-

136219, while it is possible to admire such an idea that an existing table produced beforehand is utilized. However, a precision of a table newly produced considerably depends on the existing table utilized for producing the new table.

Further, according to the proposed technology in Japanese Patent Application Laid Open Gazette Hei. 10-136219, it is impossible to represent non-linear characteristics between the color data and the chromaticity values. Thus, also in this respect, it is a problem in the point of precision.

SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of the present invention to provide a profile producing method and a profile producing apparatus for producing a profile, which is high in precision, using a color chart few in number of patches.

To achieve the above-mentioned object, the present invention provides a first profile producing method of producing a profile defining an association between a first color data representative of coordinates on a predetermined first color space and a second color data representative of coordinates on a second color space independent of output devices, for colors appearing on a color image outputted from an output device for outputting the color image in accordance with image data including the first color data, said profile producing method comprising:

a color association definition obtaining step of

of a plurality of color patches associated with coordinate points more roughly distributed as compared with a distribution of the coordinate points defined in association by said first profile, on the first color space, and measures the plurality of color patches constituting the color chart outputted from said output device to determine each of the second color data representative of each of the coordinates on the second color space, on each color patch, so that a color association definition, defining an association between the first color data representative of the coordinates on the first color space, wherein a distribution of coordinate points is more rough as compared with the first profile, and the second color data representative of coordinates on the second color space, is determined.

In the first profile producing method according to the present invention as mentioned above, it is preferable that said profile selection step determines on each of the plurality of profiles a first evaluation value for evaluating a difference between a dot gain quantity of the color association definition obtained in said color association definition obtaining step and a dot gain quantity of one of the plurality of profiles, and selects one of the plurality of profiles, which is smaller in an evaluated difference, as the first profile in accordance with the first evaluation value.

Selection of the profile close in dot gain as the

first profile makes it possible to produce a second profile with great accuracy by correcting the first profile to be adapted to a color association definition determined from the color chart.

5 Further, in the first profile producing method according to the present invention as mentioned above, it is preferable that said profile selection step determines on each of the plurality of profiles a second evaluation value for evaluating a distance between coordinate points
10 on the second color space, which are associated with identical coordinates on the first color space in accordance with the color association definition obtained in said color association definition obtaining step and one of the plurality of profiles, and selects one of the
15 plurality of profiles, which is smaller in an evaluated distance, as the first profile in accordance with the second evaluation value.

 Selection of the profile close in distance as the first profile also makes it possible to produce a second
20 profile with great accuracy.

 Furthermore, in the first profile producing method according to the present invention as mentioned above, it is preferable that said profile selection step determines on each of the plurality of profiles a first evaluation
25 value for evaluating a difference between a dot gain quantity of the color association definition obtained in said color association definition obtaining step and a dot

gain quantity of one of the plurality of profiles, and
further, said profile selection step determines on each of
the plurality of profiles a second evaluation value for
evaluating a distance between coordinate points on the
5 second color space, which are associated with identical
coordinates on the first color space in accordance with the
color association definition obtained in said color
association definition obtaining step and one of the
plurality of profiles, and selects one of the plurality of
10 profiles, which is smaller in an evaluated difference and
an evaluated distance, as the first profile in accordance
with both the first evaluation value and the second
evaluation value.

Selection of the first profile through evaluation
15 of both the dot gain quantity and the distance makes it
possible to select with greater accuracy a profile suitable
as the first profile which is the base for producing a new
second profile.

To achieve the above-mentioned object, the present
20 invention provides a second profile producing method of
producing a profile defining an association between a first
color data representative of coordinates on a predetermined
first color space and a second color data representative of
coordinates on a second color space independent of output
25 devices, for colors appearing on a color image outputted
from an output device for outputting the color image in
accordance with image data including the first color data,

said profile producing method comprising:

a profile obtaining step of obtaining a first profile defining an association between the first color data representative of coordinates on the first color space and the second color data representative of coordinates on the second color space;

a color association definition obtaining step of causing said output device to output a color chart including a plurality of color patches associated with coordinate points more roughly distributed as compared with a distribution of the coordinate points defined in association by said first profile, on the first color space, and measuring, of the plurality of color patches constituting the color chart outputted from said output device, the plurality of color patches associated with coordinate points more roughly distributed as compared with a distribution of the coordinate points defined in association by said first profile, to determine each of the second color data representative of each of the coordinates on the second color space, on each color patch, so that a color association definition, defining an association between the first color data representative of the coordinates on the first color space, wherein a distribution of coordinate points is more rough as compared with the first profile, and the second color data representative of coordinates on the second color space, is determined;

1 a curve arithmetic operating step of performing on
each combination of each of a plurality of color axes of
the first color space and each of a plurality of color axes
of the second color space an arithmetic operation for
5 determining a curve formed through coupling relatively
small number of points extracted from the color association
definition, which are plotted on a plane represented by a
color axis of the first color space and a color axis of the
second color space, while reflecting a non-linearity of a
10 curve consisting of a relatively large number of points
extracted from the first profile, which are plotted on the
plane; and

a profile producing step of producing a second
profile defining an association between the first color
15 data representative of coordinates on the first color space
and the second color data representative of coordinates on
the second color space in accordance with an assembly of
curves formed through coupling points extracted from the
color association definition obtained in said color
20 association definition obtaining step.

With respect to the color association definition
obtaining step, it is acceptable that the "color chart
including a plurality of color patches associated with
coordinate points more roughly distributed as compared with
25 a distribution of the coordinate points defined in
association by said first profile, on the first color
space" itself is the color chart associated with coordinate

points more roughly distributed as compared with a
distribution of the coordinate points defined in
association by said first profile, on the first color space,
or alternatively, it is acceptable that while the color
5 chart itself is not concerned with one "more roughly
distributed as compared with a distribution of the
coordinate points defined in association by said first
profile, on the first color space", a colorimetry is
performed on "a plurality of color patches associated with
10 coordinate points more roughly distributed as compared with
a distribution of the coordinate points defined in
association by said first profile"..

According to the second profile producing method
of the present invention as mentioned above, to determine a
15 curve formed through coupling data (second color data)
obtained by the colorimetry, the curve arithmetic operating
step determines the curve, while reflecting a non-linearity
of the first profile. This feature makes it possible to
produce the second profile with great accuracy reflecting a
20 non-linearity of the first profile.

In the second profile producing method according
to the present invention as mentioned above, it is
preferable that said curve arithmetic operating step
modifies on said each combination the curve consisting of a
25 relatively large number of points extracted from the first
profile in such a manner that relatively small number of
points extracted from the color association definition are

coupled with one another in accordance with a ratio of the second color data extracted from the color association definition, which corresponds to an identical first color data, and the second color data extracted from the first profile, so that an arithmetic operation for determining a curve formed through coupling relatively small number of points to one another is executed.

In the above-mentioned second profile producing method, it is preferable that said curve arithmetic operating step performs on said each combination a linear interpolation for the ratios associated with a plurality of first color data to determine each ratio associated with each value of the first color data, so that an arithmetic operation for moving points constituting a curve consisting of relatively large number of points extracted from the first profile is executed in accordance with the ratio.

The said curve arithmetic operating step in the second profile producing method of the present invention as mentioned above makes it possible to adopt the above-mentioned arithmetic operation method preferably. According to such an arithmetic operation method, it is possible to modify the curve consisting of relatively large number of points extracted from the first profile, reflecting a non-linearity of the curve.

In the above-mentioned second profile producing method, it is preferable that said profile obtaining step determines the first profile by correcting an existing

third profile defining an association between the first color data representative of coordinates on the first color space and the second color data representative of coordinates on the second color space in such a manner that a dot gain on each color axis of the first color space is coincident with a dot gain on each color axis determined in accordance with the color chart outputted from said output device.

According to the present invention as mentioned above, the first profile is produced to meet the dot gain of the output device on the base of the existing third profile, and the new profile is produced in accordance with the produced first profile. This feature makes it possible to produce a profile with greater accuracy.

In the above-mentioned second profile producing method, it is preferable that said first color space is defined by color axes of four colors of cyan C, magenta M, yellow Y and black K, and

said color association definition obtaining step adopts, as said color chart, a color chart composed of color patches corresponding to coordinate points not less than three points, which are designated on each axis coupling vertexes with one another of a cubic area capable of representing a color by said output device, of each sub-space where the first color space is divided into a plurality of sub-spaces defined by color axes of three colors of C, M, Y, which are associated with a plurality of

distribution of coordinate points is relatively close as compared with the color association definition obtained in said color association definition obtaining section, defining an association between the first color data
5 representative of coordinates on the first color space and the second color data representative of coordinates on the second color space; and

a profile producing section for producing a second profile defining an association between the first color
10 data representative of coordinates on the first color space and the second color data representative of coordinates on the second color space, by correcting the first profile selected in said profile selection in accordance with the color association definition obtained in said color
15 association definition obtaining section.

In the profile producing apparatus according to the present invention as mentioned above, it is acceptable that said profile selection section determines on each of the plurality of profiles a first evaluation value for
20 evaluating a difference between a dot gain quantity of the color association definition obtained in said color association definition obtaining section and a dot gain quantity of one of the plurality of profiles, and selects one of the plurality of profiles, which is smaller in an
25 evaluated difference, as the first profile in accordance with the first evaluation value.

In the profile producing apparatus according to

the present invention as mentioned above, it is acceptable
that said profile selection section determines on each of
the plurality of profiles a second evaluation value for
evaluating a distance between coordinate points on the
5 second color space, which are associated with identical
coordinates on the first color space in accordance with the
color association definition obtained in said color
association definition obtaining section and one of the
plurality of profiles, and selects one of the plurality of
10 profiles, which is smaller in an evaluated distance, as the
first profile in accordance with the second evaluation
value.

In the profile producing apparatus according to
the present invention as mentioned above, it is acceptable
15 that said profile selection section determines on each of
the plurality of profiles a first evaluation value for
evaluating a difference between a dot gain quantity of the
color association definition obtained in said color
association definition obtaining section and a dot gain
20 quantity of one of the plurality of profiles, and further,
said profile selection section determines on each of the
plurality of profiles a second evaluation value for
evaluating a distance between coordinate points on the
second color space, which are associated with identical
25 coordinates on the first color space in accordance with the
color association definition obtained in said color
association definition obtaining section and one of the

plurality of profiles, and selects one of the plurality of profiles, which is smaller in an evaluated difference and an evaluated distance, as the first profile in accordance with both the first evaluation value and the second evaluation value.

In the profile producing apparatus according to the present invention as mentioned above, it is preferable that said profile selection section comprises a display for displaying a color association definition obtained by said color association definition obtaining section and a graph showing a change of dot gain quantity of said plurality of profiles, and an operating section for selecting a desired profile from among said plurality of profiles as the first profile, and wherein said profile selection section selects the first profile in accordance with an operation of said operating section.

To select the first profile, it is acceptable that an operator selects the first profile in accordance with information as to the dot gain received.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic constitution view of an image output system.

Fig. 2 is a conceptual view of a profile of a printing machine shown in Fig. 1.

Fig. 3 is a perspective view of a personal computer.

Fig. 4 is a hardware structural view of the personal computer shown in Fig. 1.

Fig. 5 is a flowchart useful for understanding an embodiment of a first profile producing method according to the present invention.

Fig. 6 is an illustration useful for understanding processes of steps a6 to a8 of Fig. 5.

Fig. 7 is an illustration useful for understanding processes of steps a9 to a11 of Fig. 5.

Fig. 8 is a flowchart useful for understanding a first example of step a20 of Fig. 5.

Fig. 9 is a typical illustration of a dot gain.

Fig. 10 is a flowchart useful for understanding a second example of step a20 of Fig. 5.

Fig. 11 is a flowchart useful for understanding a third example of step a20 of Fig. 5.

Fig. 12 is a flowchart useful for understanding an embodiment of a second profile producing method according to the present invention.

Figs. 13(A)-(D) are views each showing the association (x marks) between dot% on data determined from a color chart and dot% taking into consideration a dot gain, and the association (a curve) between dot% data on a table TO typically shown in Fig. 12 and dot% taking into consideration a dot gain.

Figs. 14(A)-(D) are views each showing a curve after correction made in such a manner that a dot gain

determined from the table is coincident with a dot gain determined from the color chart.

Fig. 15 is a typical illustration showing a state that CMYK space is divided into CMY sub-spaces wherein K = 0%, 10%, 20%, ..., 100%.

Fig. 16 is an illustration typically showing one of the cubes determined as shown in Fig. 15.

Fig. 17 is a functional block diagram of a profile producing apparatus according to the present invention.

Fig. 18 is a view showing display screens displayed on a display of the profile producing apparatus.

Fig. 19 is a flowchart useful for understanding the conventional method of producing a profile.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments of the present invention will be described with reference to the accompanying drawings.

Fig. 1 is a schematic constitution view of an image output system.

Fig. 1 shows a personal computer 10 and a printing machine 20.

The personal computer 10 receives image data obtained through reading an image by a color scanner (not illustrated) for instance, and image data obtained through photography by a digital still camera (DSC). Or alternatively, it is possible to cause the personal computer 10 to generate, for example, image data for a

color chart. Image data fed to the personal computer 10 is converted inside the personal computer 10, when it is intended that an image based on the image data is outputted from the printing machine 20, into image data
5 representative of the respective dot% of CMYK suitable for the printing machine 20.

To perform such a conversion, a profile involved in the printing machine 20, which is representative of the association between color data to be transmitted to the
10 printing machine 20 and colors (chromaticity values) on a color image to be printed and outputted by the printing machine 20, is referred to so as to perform a conversion in such a manner that a color image 21 having a desired color representation is printed and outputted by the printing
15 machine 20. Here, a color representation on a color image is noticed. Such a conversion as to colors is referred to as a "color conversion".

While Fig. 1 shows the printing machine 20 by way of example of the output device, the output device is not
20 restricted to a printing machine, but it is acceptable that the output device is, for example, a color printer. Also in the event that the color printer is adopted as the output device, it is acceptable that the color printer is an electrophotographic scheme of color printer, an ink jet
25 scheme of color printer, or a printer of such a scheme that a printing paper is exposed with a modulated laser beam and then developed. Further, it is acceptable that the output

device is an image display unit such as a CRT display unit and a plasma display unit for displaying an image on a display screen. Here, the explanation will be continued taking the printing machine 20 by way of example.

5 Fig. 2 is a conceptual view of a profile of the printing machine 20 shown in Fig. 1.

 A printing profile 22 is representative of color reproduction characteristics of the printing machine 20, and is referred to as a printing profile. The printing
10 profile 22 represents the association between the color data (here it is color data representative of the respective dot% of CMYK, and in some case, it is referred to as "CMYK data") after color conversion by the personal
15 computer 10 and chromaticity values (here XYZ values) representative of colors on an color image to be printed and outputted in accordance with the color data. According to the present embodiment, a color space defined by color axes of CMYK corresponds to the first color space referred to in the present invention. A color space for defining
20 chromaticity values (XYZ values) corresponds to the second color space, which is independent of devices, referred to in the present invention. Accordingly, in the present embodiment, the CMYK data corresponds to the first color data referred to in the present invention, and color data
25 (in some case, it is referred to as "XYZ data") representative of XYZ values corresponds to the second color data referred to in the present invention.

Referring to the printing profile 22 makes it possible to know what color of printed matter is obtained when what CMYK data is fed to the printing machine 20.

The printing profile 22 is varied for each printing machine of course, but is varied in accordance with a type of a printing machine and a printing condition for the same printing machine, such as a sort of ink to be used and a sort of printing paper to be used.

Here, there will be described the "second color space, which is independent of devices", referred to in the present invention.

With respect to the second color space, while it is explained in the above that the XYZ color space is an example of the second color space, there is no need that the second color space is the XYZ color space. Any one is acceptable, as the second color space, which is defined in such a manner that it is independent of a specified device. For example, it is acceptable that the second color space is $L^*a^*b^*$ color spaces (CIELAB color spaces), or alternatively it is acceptable that the second color space is a coordinate system clearly defined in such a manner that coordinate points on the color spaces are associated with the color spaces one by one. As an example of such a coordinate system, there is a standard RGB signal defined as follows.

$$\begin{bmatrix} R_{sRGB} \\ G_{sRGB} \\ B_{sRGB} \end{bmatrix} = \begin{bmatrix} 3.2410 & -1.5374 & -0.4986 \\ -0.9692 & 1.8760 & 0.0416 \\ 0.0556 & -0.2040 & 1.0570 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

Assuming that R_{8bit} denotes one wherein R_{sRGB} is expressed by 8bits, the following expression is given.

$$\begin{aligned} 5 \quad R_{8bit} &= 255 \times 12.92 R_{sRGB} \quad (0 < R_{sRGB} < 0.00304) \\ R_{8bit} &= 255 \times 1.055 R_{sRGB}^{(1.0/2.4)} - 0.055 \quad (0.00304 \leq R_{sRGB} \leq 1) \end{aligned}$$

Also as to G_{8bit} and B_{8bit} wherein G_{sRGB} and B_{sRGB} are expressed by 8bits, respectively, similarly, G_{8bit} and B_{8bit} can be converted from G_{sRGB} and B_{sRGB} , respectively.

Alternatively, it is acceptable that a color space defined by cmY density of a reversal film is adopted as a common color space. According to the present embodiment, a color space defining the chromaticity values (XYZ data) will be explained as the second color space.

The personal computer 10 shown in Fig. 1 corresponds to an embodiment of a profile producing apparatus of the present invention, and is used in part of an embodiment of a profile producing method of the present invention. Thus, first, there will be explained the personal computer 10 hereinafter.

Fig. 3 is a perspective view of the personal computer 10 shown in Fig. 10 with one block. Fig. 4 is a hardware structural view of the personal computer 10.

The personal computer 10 comprises, on an external appearance, a main frame unit 11, an image display unit 12

for displaying an image on a display screen 12a in
accordance with an instruction from the main frame unit 11,
a keyboard 13 for inputting various sorts of information to
the main frame unit 11 in accordance with a key operation,
5 and a mouse 14 for inputting an instruction according to,
for example, an icon and the like, through designation of
an optional position on the display screen 12a, the icon
and the like being displayed on the position on the display
screen 12a. The main frame unit 11 has a floppy disk
10 mounting slot 11a for mounting a floppy disk, and a CD-ROM
mounting slot 11b for mounting a CD-ROM.

The main frame unit 11 comprises, as shown in Fig.
4, a CPU 111 for executing a various types of program, a
main memory 112 in which a program stored in a hard disk
15 unit 113 is read out and developed for execution by the CPU
111, the hard disk unit 113 for saving various types of
programs and data, an FD drive 114 for accessing a floppy
disk 110 mounted thereon, a CD-ROM drive 115 for accessing
a CD-ROM 120 mounted thereon, an input interface 116
20 connected to an input device for inputting an image, for
example, a color scanner (not illustrated) and a digital
still camera (not illustrated), to receive image data from
the input device, and an output interface 117 connected to
the printing machine 20 (cf. Fig. 1) to transmit image data
25 to the printing machine 20. These various types of
elements are connected via a bus 15 to the image display
unit 12, the keyboard 13 and the mouse 14.

associated with coordinate points on C axis, and assembly
of data associated with coordinate points on M axis.
Details of the computation category will be described later
together with an explanation of a way of selection of CMYK
5 data for outputting the color chart.

Part (a6) of Fig. 6 shows, by way of a typical
example of a number of computation categories, a category i
consisting of assembly of data associated with coordinate
points on C axis, that is, assembly of data wherein all M,
10 Y and K are 0%, and C is 0%, 40% and 100%. The horizontal
axis of part (a6) of Fig. 6 denotes dot% of cyan (C), and
the vertical axis denotes chromaticity values (here values
of X, Y and Z of XYZ data). Each of graphs shown in parts
(a6), (7) and (8) of Fig. 6, and parts (a9) to (a11) of Fig.
15 7 corresponds to a plane represented by one color axis of
the first color space (CMYK space) referred to in the
present invention and one color axis of the second color
space (XYZ space) referred to in the present invention.

In part (a6) of Fig. 6, there are plotted data
20 (only X data is exemplarily shown) on X, Y, Z for CMYK data
of $(C, M, Y, K) = (0\%, 0\%, 0\%, 0\%,)$, $(40\%, 0\%,$
 $0\%, 0\%,)$, $(100\%, 0\%, 0\%, 0\%,)$, on planes defined
by C axis in the horizontal axis and axes of X, Y, Z in
vertical axis.

25 In step a7 shown in Fig. 5, as shown in part (a7)
of Fig. 6, chromaticity values (data on X, Y, Z)
represented by the graph shown in part (a6) of Fig. 6 are

are subjected to a linear interpolation to determine the ratio k for each $\text{dot}\%$ so that $k \cdot Q$ is determined for each $\text{dot}\%$.

For example, with respect to 20% in $\text{dot}\%$, $k_{20} = k_{40} \times 20 / 40 = 0.5 \cdot k_{40}$, and with respect to 10% in $\text{dot}\%$, $k_{10} = 40 \times 10 / 40 = 0.25 \cdot k_{40}$ are given.

Also in the range of 40% to 100% in $\text{dot}\%$, the ratio of k_{40} and the ratio of $k_{100} = 0$ at 100% are subjected to a linear interpolation to determine the ratio k for each $\text{dot}\%$ so that $k \cdot Q$ is determined for each $\text{dot}\%$.

For example, with respect to 60%,

$$\begin{aligned} k_{60} &= k_{40} \times (100 - 60) / (100 - 40) \\ &= (2/3) \cdot k_{40} \end{aligned}$$

Thus, a correction of the value Q makes it possible to obtain a curve (x marks) coincident with the value P (O marks), as shown in part (a10) of Fig. 7. The curve (x marks) is coincident with the value P (O marks), and reflects a nonlinearity which is possessed by a curve composed of the original values Q (cf. part (a9) of Fig. 7) before correction, that is, a nonlinearity of the table $T1$ (cf. part (a8) of Fig. 6) from which the values Q are extracted.

The corrected values Q thus determined are normalized into 0.0 to 1.0. Thus, the corrected values Q are returned to the chromaticity value X (or Y, Z), as shown in part (a11) of Fig. 7, in accordance with the inverse transformation of the formula (1), that is, the

following formula (2) (step a10 of Fig. 5).

$$X = X_{100} + (X_0 - X_{100}) \cdot X' \quad \dots (2)$$

X : value Q after inverse transformation

5 X₀ : value P before normalization according to
the formula (1) where dot% is 0%

X₁₀₀ : value P before normalization according to
the formula (1) where dot% is 100%

X' : corrected value Q

10 Next, in step a11 of Fig. 5, values necessary for
a table producing computation (computation A) in step a13
of Fig. 5 are extracted from the curve (x marks of the part
(a11) of Fig. 7) of the chromaticity values thus determined,
so that the association M between the color data (CMYK
data) and the chromaticity values (XYZ data) is produced.
15 This association M corresponds to the association M which
is produced in the step e5 of the method of producing the
profile shown in Fig. 19, but is different in the point
that the former association M is produced using colorimetry
data of a small number of color patches and the existing
20 table T1.

According to the method explained referring to Fig.
19, a color chart composed of a large number of color
patches is outputted to measure the large number of color
patches so that the association M is obtained. On the
25 other hand, according to the present embodiment shown in
Fig. 5, a color chart composed of less color patches is
outputted to measure a small number of color patches so

that the association M (cf. step a5 of Fig. 5) is produced, and the arithmetic operation using the table T1 makes it possible to produce the association M which is larger in scale (large number in the associated parameters) than the association N, while reflecting a nonlinearity of the table T1. Thus, according to the present embodiment, it is possible to reduce the number of color patches constituting a color chart and thereby saving the trouble of colorimetry. And reflecting the nonlinearity of the table T1 makes it possible to produce the association M with greater accuracy as compared with the association M produced by a actual measurement according to the method of Fig. 19.

In step a13 of Fig. 5, the same computation (computation A) as the step e6 of the method shown in Fig. 19 is executed in accordance with the association M, so that the table T2 (corresponding to an example of the second profile referred to in the present invention) of interest is produced.

According to the present embodiment, the process of the steps a6 to a14 corresponds to the profile producing process referred to the first profile producing method of the present invention.

Incidentally, according to the present embodiment, the computation A is executed after the association M is produced once. The reason why this is to do so is that the computation program, which performs the computation A adopted also in the method of Fig. 19, is utilized as it is.

However, there is no need to always adopt part of the conventional method, it is acceptable that the table T2 is computed directly from the curve (x marks of part (all) of Fig. 7) of the chromaticity values determined from the step
5 all of Fig. 5.

Next, there will be described an embodiment of the profile selection process referred to the first profile producing method of the present invention, which profile selection process is shown in the step a20 of Fig. 5.

10 Fig. 8 is a flowchart useful for understanding a first example of the step a20 of Fig. 5.

In step b1 of Fig. 8, from the association N between data (CMYK data) and the chromaticity values (XYZ data), which is obtained through colorimetry of the
15 outputted color chart, data on 0%, 50% and 100% of monochromatic gradation (on color axis of each of C, M, Y and K in CMYK color space) of each of C, M, Y and K are picked up. In step b2, dot% (50%) taking into consideration the dot gain, involved in 50% in dot% on data,
20 is determined on each of C, M, Y and K in accordance with the formula (3) of Murray-Davis.

To determine dot% taking into consideration the dot gain, it is assumed that X is used as the chromaticity value, then dot% may be is determined in accordance with
25 the following formula (3).

$$a = \{(1 - 10^{-(X - X_0)}) / (1 - 10^{-(X_{100} - X_0)})\} \times 100 \quad \dots\dots (3)$$

the steps b1 to b3, dot gain quantity is determined on each of a plurality of existing tables T (cf. step 20a of Fig. 5).

That is, in step b4, from the tables T, data on 0%, 50% and 100% of monochromatic gradation (on color axis of each of C, M, Y and K in CMYK color space) of each of C, M, Y and K are picked up. In step b5, dot% referring to the dot gain involved in 50% in dot% on data, is determined on each of C, M, Y and K in accordance with the formula (3) of Murray-Davis. In step b6, dot gain quantity D_p is determined on each of C, M, Y and K in accordance with the formula similar to the formula (4). The dot gain quantities of C, M, Y and K, which are determined from the tables T, are denoted by D_{pc} , D_{pm} , D_{py} , D_{pk} , respectively.

In step b7, the evaluation value α , which is composed of sums of differences between the dot gain quantities D_{mc} , D_{mm} , D_{my} , D_{mk} determined from the association N in the steps b1 to b3 and the dot gain quantities D_{pc} , D_{pm} , D_{py} , D_{pk} determined from the table T in the steps b4 to b6, is determined in accordance with the following formula (5).

$$\alpha = (D_{pc} - D_{mc}) + (D_{pm} - D_{mm}) + (D_{py} - D_{my}) + (D_{pk} - D_{mk}) \dots (5)$$

The evaluation value α corresponds an example of the first evaluation value referred to in the present invention.

The evaluation value α according to the formula (5) is determined on each of a plurality of existing tables

T. In step b8, a table T, wherein the evaluation value α determined in the step b7 is the minimum, of the plurality of existing tables T, is selected as the table T1 (cf. step a20).

5 In this manner, the table wherein the dot gain is closest to a dot gain involved in the present printing condition, is selected from the existing tables T, so that a precise table T2 is produced in accordance with the flowchart of Fig. 5.

10 Incidentally, according to the above, while the evaluation value α is determined in accordance with the formula (5), any one is acceptable, as the evaluation value α , which can evaluate the difference between the dot gain determined from the color chart (the association N) and the
15 dot gain determined from the tables T, and there is no need that the evaluation value α is determined always in accordance with the formula (5).

It is acceptable the evaluation value α is determined, for example, in accordance with the following
20 formula (6).

$$\alpha = (D_{pc} - D_{mc})^2 + (D_{pm} - D_{mm})^2 + (D_{py} - D_{my})^2 + (D_{pk} - D_{mk})^2 + \dots \quad (6)$$

Further, according to the above, the evaluation value α is determined in accordance with the dot gain of a
25 monochrome on each of CMYK, it is acceptable that dot gain on a gray axis (color axis satisfying $C = M = Y$) of CMYK color space where for example, $K = 0\%$) is determined, and

the evaluation value α is determined in accordance with the dot gain on the gray axis.

Fig. 10 is a flowchart useful for understanding a second example of the step a20 of Fig. 5.

Here, in step c1, XYZ data is determined from the association N and the tables T on each of the combinations of 0% and 100% for CMYK, that is, 16 ways of combination of:

- 1 : (C, M, Y, K) = (0, 0, 0, 0)
 - 2 : (C, M, Y, K) = (100, 0, 0, 0)
 - 3 : (C, M, Y, K) = (0, 100, 0, 0)
 - 4 : (C, M, Y, K) = (0, 0, 100, 0)
 - 5 : (C, M, Y, K) = (0, 0, 0, 100)
 - 6 : (C, M, Y, K) = (100, 100, 0, 0)
 - ...
 - 16 : (C, M, Y, K) = (100, 100, 100, 100)
- (7)

Values of XYZ, which are determined from the association N, are denoted by X_m , Y_m , Z_m , respectively, and more specifically denoted by X_{m1} , Y_{m1} , Z_{m1} , X_{m2} , Y_{m2} , Z_{m2} , ... applying suffixes 1 to 16 in association with CMYK data of the above 16 ways of numbers of 1 to 16.

Similarly, Values of XYZ, which are determined from the tables, are denoted by X_p , Y_p , Z_p , respectively, and more specifically denoted by X_{p1} , Y_{p1} , Z_{p1} , X_{p2} , Y_{p2} , Z_{p2} , ... applying suffixes 1 to 16 in association with CMYK data of the above 16 ways of numbers of 1 to 16.

Next, in step c2, an evaluation value β , which evaluates a distance between (X_m, Y_m, Z_m) and (X_p, Y_p, Z_p) , is determined in accordance with the following formula (8).

The evaluation value β corresponds to an example of the second evaluation value referred to the present invention.

$$\begin{aligned} \beta = & (X_{p1} - X_{m1})^2 + (X_{p2} - X_{m2})^2 + \dots + (X_{p16} - X_{m16})^2 \\ & + (Y_{p1} - Y_{m1})^2 + (Y_{p2} - Y_{m2})^2 + \dots + (Y_{p16} - Y_{m16})^2 \\ & + (Z_{p1} - Z_{m1})^2 + (Z_{p2} - Z_{m2})^2 + \dots + (Z_{p16} - Z_{m16})^2 \dots \end{aligned}$$

(8)

The processing of determining XYZ values involved in the tables T in the step c1 and the arithmetic operation based on the formula (8) in the step c2 are performed on each of a plurality of existing tables T (cf. the step a20 of Fig. 5). In step c3, a table, wherein the evaluation value β is the minimum, of the plurality of existing tables T, is selected as the table T1 (cf. step a20).

In this manner, the table T, which has XYZ values close to XYZ values determined from the color chart (the association N), associated with the same CMYK data, is selected as a table T1, so that a precise new table T2 (cf. step a14 of Fig. 5) is produced using the table T1.

Incidentally, according to the above, while the evaluation value β is determined in accordance with the formula (8), any one is acceptable, as the evaluation value β , which can evaluate the distance between the coordinate points on XYZ color space determined from the color chart (the association N), associated with coordinate points on the same CMYK color space, and the coordinate points on XYZ color space determined from the tables T, and there is no need that the evaluation value β is determined always in

accordance with the formula (8).

It is acceptable the evaluation value β is determined, for example, in accordance with the following formula (9).

5

$$\begin{aligned} \beta = & \sqrt{(X_{p1} - X_{m1})^2} + \sqrt{(X_{p2} - X_{m2})^2} + \dots + \sqrt{(X_{p16} - X_{m16})^2} \\ & + \sqrt{(Y_{p1} - Y_{m1})^2} + \sqrt{(Y_{p2} - Y_{m2})^2} + \dots + \sqrt{(Y_{p16} - Y_{m16})^2} \\ & + \sqrt{(Z_{p1} - Z_{m1})^2} + \sqrt{(Z_{p2} - Z_{m2})^2} + \dots + \sqrt{(Z_{p16} - Z_{m16})^2} \\ & \dots (8) \end{aligned}$$

10

According to the above-mentioned second example, while there is determined the evaluation value β for evaluating the 'distance' of XYZ values on the combinations (formula (7)) of 0% and 100% in CMYK, it is acceptable that the evaluation value β is determined in accordance with the formula similar to the formula (8) or (9) on each of combinations of 0%, 50% and 100% in CMYK, instead of the combinations of 0% and 100% in CMYK, that is, the combinations as set forth below.

15

20

$$\begin{aligned} (C, M, Y, K) &= (0, 0, 0, 0) \\ (C, M, Y, K) &= (50, 0, 0, 0) \\ &\dots \end{aligned}$$

$$\begin{aligned} (C, M, Y, K) &= (100, 0, 0, 0) \\ &\dots \end{aligned}$$

25

$$\begin{aligned} (C, M, Y, K) &= (50, 50, 0, 0) \\ &\dots \end{aligned}$$

$$\begin{aligned} (C, M, Y, K) &= (50, 50, 50, 50) \\ &\dots \end{aligned}$$

$$(C, M, Y, K) = (100, 50, 50, 100)$$

30

$$\begin{aligned} &\dots \\ (C, M, Y, K) &= (100, 100, 100, 100) \end{aligned}$$

..... (10)

$$(C, M, Y, K) = (50, 50, 50, 50)$$

$$(C, M, Y, K) = (100, 100, 100, 100) \cdots \cdots (12)$$

In the event that color is coincident in monochrome, but the color is varied in superposition of the monochrome, it is acceptable to roughly decide a degree of an approximation of color space characteristics through determination also including four colors-superposed portion adding formulas (11) and (12).

According to the second example and the various modifications thereof, a distance between coordinate points on XYZ color space, for the same coordinate points on CMYK color space, is evaluated. It is acceptable that as the association N and the tables T, an association between CMYK data and a 'distance' on L*a*b* color space is defined beforehand, and to determine the evaluation value β for evaluating the 'distance', the evaluation value for evaluating the 'distance' on the L*a*b* color space is determined.

Fig. 11 is a flowchart useful for understanding a third example of the step a20 of Fig. 5.

Here, first, in step d1, an evaluation value α , which represents a difference in the dot gain as compared with the color chart (the association N) on each of a plurality of existing tables T, is determined. The step d1 corresponds to the steps b1 to b7 of Fig. 8.

When the evaluation value α is determined on each

of the tables T, the process goes to a step d2 in which tables T, wherein the evaluation value α is less than a predetermined threshold C, are selected. At this stage, generally, a plurality of tables T still remain.

5 In step d3, there is determined the evaluation value β for evaluating the 'distance', which is explained referring to Fig. 10 with respect to the tables T selected in the step d2. The step d3 corresponds to the steps c1 to c2 of the flowchart of Fig. 10.

10 In step d4, a table, in which the evaluation value β determined in the step d3 is minimum, is selected as the table T1 (cf. the step a20).

In this manner, an adoption of a method that both the dot gain and the distance are evaluated to select the table T makes it possible to more surely select a table which suits one to be selected as the table T1.

15 Fig. 12 is a flowchart useful for understanding an embodiment of a second profile producing method according to the present invention.

20 The flowchart of Fig. 12 is different from the flowchart of Fig. 5, which relates to the embodiment of the first profile producing method of the present invention, in the point that the flowchart of Fig. 12 has a step a21 instead of the step a20 of Fig. 5, and is similar to that of Fig. 5 with respect to the remaining steps a1 to a14. Accordingly, the explanation of the steps a1 to a14 of the flowchart of Fig. 12 will be omitted, and there will be

explained the step a21 hereinafter.

In comparison of the flowchart of Fig. 12 with the second profile producing method of the present invention, the association N obtained in the step a5 of Fig. 12 corresponds to the color association definition referred to the second profile producing method of the present invention, and the process of the steps a1 to a5 corresponds to the color association definition obtaining process referred to the second profile producing method of the present invention. The process of the steps a6 to a10 corresponds to the curve arithmetic operation process referred to the second profile producing method of the present invention. The process of the steps a11 to a14 corresponds to the profile producing process referred to the second profile producing method of the present invention. The step a21 of Fig. 12 is concerned with a process of producing the table T1 from the table T0. According to the present embodiment, a preparation of the table T1, including that the existing table is simply selected without newly producing the table T1 from the table T0, corresponds to the profile obtaining process referred to the second profile producing method of the present invention.

Next, there will be explained an example of the profile obtaining process referred to the second profile producing method of the present invention, which is shown in the step a21 of Fig. 12.

Here, the table T0 is one of the profiles of the printing machine 20 shown in Fig. 1, which corresponds to a printing condition different from a printing condition involved in the table (the printing profile) intended now to be produced. In the event that as a candidate for the table T1, a plurality of tables exist, it is preferable to select a table of the printing condition close to the printing condition involved in the table intended now to be produced.

In the step a21 of Fig. 12, the table T1 is produced from the table T0 in the manner as set forth below.

Figs. 13 (A)-(D) are views each showing the association (x marks) between dot% on data determined from a color chart and dot% taking into consideration a dot gain, and the association (a curve) between dot% data on a table T0 typically shown in Fig. 12 and dot% taking into consideration a dot gain. Figs. 14(A)-(D) are views each showing a curve after correction made in such a manner that a dot gain determined from the table is coincident with a dot gain determined from the color chart.

C_{in} , M_{in} , Y_{in} and K_{in} of the horizontal axis of Figs. 13 (A)-(D) denote dot% values of C, M, Y and K of CMYK data at the time of output of the color chart, respectively, and the vertical axes denote dot% values of C, M, Y and K taking into consideration the dot gain, which will be obtained in accordance with the formula (3) of Murray-Davis as mentioned above.

To determine dot% taking into consideration the dot gain, assuming that X is used as the chromaticity value, the dot% is determined in accordance with the formula (3) of Murray-Davis as mentioned above.

5 Here, as mentioned above, to determine dot% taking into consideration the dot gain of C color, M color, Y color and K color, chromaticity values X, Y, Z and K are used.

Dot% a is determined in accordance with the above-mentioned formula (3) and is dot% of the vertical axis.

To determine C_{out} at $C_{in} = 40\%$ as shown in Fig. 13(A), for example, the dot% a is determined in such a manner that the chromaticity value X, which is obtained through measuring the color patch produced in accordance with CMYK data of $C_{in} = 40\%$, $M_{in} = Y_{in} = K_{in} = 0\%$, is substituted for the formula (3). Assuming that the dot% a is 50%, a mark x is plotted at the point $(C_{in}, C_{out}) = (40\%, 50\%)$. The similar arithmetic operation is performed on each point of the mark x.

20 This is similar also with respect to each of the curves of Figs. 13 (A)-(D). To explain the curve of Fig. 13(A) for example, coordinate points on C axis of the table TO are denoted by C_{in} , and the associated dot gain a is determined in accordance with the formula (3) using the chromaticity value X corresponding to the associated C_{in} . A sum of C_{in} and the dot gain a is C_{out} . The curve shown in Fig. 13(A) is provided when the coordinate points

determined by the respective C_{in} and C_{out} . This is applicable also to M, Y, K.

Here, there is performed such a correction that the curves of Figs. 13 (A)-(D) overlaps with points (marks x) determined in accordance with the color chart. That is, here, by way of example, each curve is expressed by a polynomial, and a parameter of the polynomial expression is controlled so that the curve overlaps with points determined in accordance with the color chart. The table T0 is converted into the table T1 in accordance with the curve thus obtained. For example, as shown in Fig. 14(A), in the even that the association between $(C, M, Y, K) = (40\%, 0\%, 0\%, 0\%)$ and a certain chromaticity value XYZ is provided, the table T0 performs such an arithmetic operation that C axis is partially expanded and compressed, so that $(C, M, Y, K) = (50\%, 0\%, 0\%, 0\%)$ is associated with the same chromaticity value XYZ. Such an arithmetic operation is performed on each of axes of C, M, Y and K. Thus, it is possible to produce a table T1. The table T1 matches a dot gain produced on the basis of the table T0 with a dot gain in the printing condition involved in the new table T2 (cf. step a14 of Fig. 12) which is intended now to be produced.

In the step a21 of Fig. 12, the existing table T0 (an example of the third profile referred to in the second profile producing method of the present invention) is obtained, and there is produced a table T1 in which a dot

gain is corrected so that the dot gain of the table T0 is coincident with the dot gain determined in accordance with the color chart. To produce a table T2, there is used the table T1 in which a dot gain is corrected.

5 Thus, the use of the table T1 in which a dot gain is corrected makes it possible to produce the table T2 with greater accuracy.

Fig. 15 is a typical illustration showing a state that CMYK space is divided into CMY sub-spaces wherein K =
10 0%, 10%, 20%, ..., 100%.

Each CMY sub-space is a three-dimensional space, and each value of CMY is expressed by 0% to 100%. Thus, an area (color reproduction area), in which the printing machine 20 (cf. Fig. 1) can reproduce a color, is
15 represented by a cube on a three-dimensional space composed of CMY.

Fig. 16 is an illustration typically showing one of the cubes determined as shown in Fig. 15.

In Fig. 16, each of black dots denotes a
20 coordinate point corresponding to the associated one of the color patches constituting a color chart, while Fig. 16 shows only part of the black dots. The coordinate points (CMYK data) for outputting the color patches are subjected to a one-point selection, for example, on each side (solid
25 lines shown in Fig. 16) of each cube shown in Fig. 15, each diagonal (dotted lines shown in Fig. 16), both ends of each diagonal (dashed line shown in Fig. 16) inside the cube,

and the middle therebetween.

In the step a6 (part (a6) of Fig. 6) of Figs. 5 and 12, data groups aligned on those sides and diagonals are classified in form of a computation category.

5 The black dots of the cube in Fig. 16 also denote coordinate points representative of the association N produced in the step a5 in Fig. 5. On the other hand, the association M, which is determined in the step a12 of Fig. 5 and the step e5 of Fig. 19, is represented by coordinate
10 points represented by the black dots and hatched circles, the number of which is considerably larger than the association N, while Fig. 16 shows only Y axis. And the table, which is finally produced, is represented by
15 coordinate points represented by the black dots and hatched circles, and in addition white circles, the number of which is further larger, while Fig. 16 shows only Y axis.

In this manner, the utilizing nonlinearity characteristics of the existing table T1 (or table T1 corrected in the dot gain of the existing table T0) makes
20 it possible to produce the table T2 with great accuracy using a color chart composed of color patches which are less than the conventional one in the number, and also possible to greatly save the trouble up to producing the table T2.

25 Fig. 17 is a functional block diagram of a profile producing apparatus according to the present invention.

A profile producing apparatus 300 shown in Fig. 17

is implemented by a combination of the hardware of the personal computer 10 shown in Figs. 3 and 4 and the software to be executed in the personal computer 10.

5 The profile producing apparatus 300 comprises a color association definition obtaining section 310, a profile producing section 320, a profile selection section 330, an operating section 340 and a display 350.

10 The color association definition obtaining section 310 inputs to the profile producing apparatus 300 a color association definition corresponding to the association N produced in the step a5 of Fig. 5. When the color association definition is transmitted through a communication, the interface 116 shown in Fig. 4 corresponds to the color association definition obtaining section 310. Alternatively in the event that an operator
15 inputs through the keyboard 13 shown in Fig. 3 the color association definition (the association N) which is produced in the manner as explained referring to Fig. 5, the keyboard 13 corresponds to the color association definition obtaining section 310. In the event that the produced color association definition (the association N) is stored in the floppy disk 110 (cf. Fig. 4), and the color association definition stored in the floppy disk 110 is fed to the profile producing apparatus 300 (the personal
20 computer 10), the FD drive 114 shown in Fig. 4 corresponds to the color association definition obtaining section 310.

The profile producing section 320 of the profile

definition obtaining section 310 and the table T1 selected by the profile selection section 330.

The profile producing apparatus 300 has a mode in which a table T1 is selected from among a plurality of existing tables T in accordance with an operation, as will be described later.

Fig. 18 is a view showing display screens displayed on the display 350 of the profile producing apparatus 300.

Fig. 18 shows dot gain curves (solid lines) of C, M, Y and K determined from the color association definition (the association N) obtained by the color association definition obtaining section 310, and dot gain curves (dashed lines) of C, M, Y and K, which are determined from the table (here table A) selected in accordance with an operation of the operating section 340 (for example, the mouse 14 shown in Fig. 3) by an operator from among a plurality of existing tables T (tables A, B and C). When the table B or C is selected, instead of the table A, through operation of the operating section 340, the dot gain curve of the table B or C is displayed, instead of the dot gain curve of the table A.

An operator compares the dot gain curve of each of the tables A, B and C with the dot gain curve of the color association definition, so as to select through an operation of the operating section 340 a table, in which the dot gain curve is closest to the dot gain curve of the

color association definition, from among the tables A, B and C.

In the profile producing apparatus 300 shown in Fig. 17, the table T1 thus selected is transmitted to the profile producing section 320 to produce a new table T2.

Thus, it is preferable that the profile producing apparatus 300 has a man-machine interface and is arranged in such a manner that information useful for a decision of an operator is displayed so that the operator can select the table T1.

According to the present embodiment, to produce the table T2 in a certain printing condition of the printing machine 20 (cf. Fig. 1), the existing table T1 is selected in the different printing condition of the same printing machine (or the existing table T0 is used). However, alternatively, it is acceptable that the table T1 is selected from among the tables produced by a different type of printing machine, similar in the printing condition for example, or the table produced by such a different type of printing machine is used as the table T0.

According to the present embodiments as mentioned above, by way of example of the output device, a printing machine is explained, but the present invention is not restricted to only a case where a profile of the printing machine is produced, and it is applicable widely to output devices.

As mentioned above, according to the present

invention, it is possible to produce a profile with great accuracy saving trouble.

While the present invention has been described with reference to the particular illustrative embodiments, it is not to be restricted by those embodiments but only by the appended claims. It is to be appreciated that those skilled in the art can change or modify the embodiments without departing from the scope and sprit of the present invention.

WHAT IS CLAIMED IS:

1. A profile producing method of producing a profile defining an association between a first color data representative of coordinates on a predetermined first color space and a second color data representative of coordinates on a second color space independent of output devices, for colors appearing on a color image outputted from an output device for outputting the color image in accordance with image data including the first color data, said profile producing method comprising:

a color association definition obtaining step of obtaining a color association definition, in which distribution of coordinate points is relatively rough, defining an association between the first color data representative of coordinates on the first color space and the second color data representative of coordinates on the second color space;

a profile selection step of selecting a first profile from among a plurality of profiles, in which distribution of coordinate points is relatively close as compared with the color association definition obtained in said color association definition obtaining step, defining an association between the first color data representative of coordinates on the first color space and the second color data representative of coordinates on the second color space; and

a profile producing step of producing a second profile defining an association between the first color data representative of coordinates on the first color space and the second color data representative of coordinates on the second color space, by correcting the first profile selected in said profile selection step in accordance with the color association definition obtained in said color association definition obtaining step.

2. A profile producing method according to claim 1, wherein said color association definition obtaining step causes said output device to output a color chart composed of a plurality of color patches associated with coordinate points more roughly distributed as compared with a distribution of the coordinate points defined in association by said first profile, on the first color space, and measures the plurality of color patches constituting the color chart outputted from said output device to determine each of the second color data representative of each of the coordinates on the second color space, on each color patch, so that a color association definition, defining an association between the first color data representative of the coordinates on the first color space, wherein a distribution of coordinate points is more rough as compared with the first profile, and the second color data representative of coordinates on the second color space, is determined.

of the plurality of profiles a first evaluation value for
evaluating a difference between a dot gain quantity of the
color association definition obtained in said color
association definition obtaining step and a dot gain
5 quantity of one of the plurality of profiles, and further,
said profile selection step determines on each of the
plurality of profiles a second evaluation value for
evaluating a distance between coordinate points on the
second color space, which are associated with identical
10 coordinates on the first color space in accordance with the
color association definition obtained in said color
association definition obtaining step and one of the
plurality of profiles, and selects one of the plurality of
profiles, which is smaller in an evaluated difference and
15 an evaluated distance, as the first profile in accordance
with both the first evaluation value and the second
evaluation value.

6. A profile producing method of producing a
20 profile defining an association between a first color data
representative of coordinates on a predetermined first
color space and a second color data representative of
coordinates on a second color space independent of output
devices, for colors appearing on a color image outputted
25 from an output device for outputting the color image in
accordance with image data including the first color data,
said profile producing method comprising:

each combination of each of a plurality of color axes of the first color space and each of a plurality of color axes of the second color space an arithmetic operation for determining a curve formed through coupling relatively small number of points extracted from the color association definition, which are plotted on a plane represented by a color axis of the first color space and a color axis of the second color space, while reflecting a non-linearity of a curve consisting of a relatively large number of points extracted from the first profile, which are plotted on the plane; and

a profile producing step of producing a second profile defining an association between the first color data representative of coordinates on the first color space and the second color data representative of coordinates on the second color space in accordance with an assembly of curves formed through coupling points extracted from the color association definition obtained in said color association definition obtaining step.

7. A profile producing method according to claim 6, wherein said curve arithmetic operating step modifies on said each combination the curve consisting of a relatively large number of points extracted from the first profile in such a manner that relatively small number of points extracted from the color association definition are coupled with one another in accordance with a ratio of the second

color data extracted from the color association definition,
which corresponds to an identical first color data, and the
second color data extracted from the first profile, so that
an arithmetic operation for determining a curve formed
5 through coupling relatively small number of points to one
another is executed.

8. A profile producing method according to claim
7, wherein said curve arithmetic operating step performs on
10 said each combination a linear interpolation for the ratios
associated with a plurality of first color data to
determine each ratio associated with each value of the
first color data, so that an arithmetic operation for
moving points constituting a curve consisting of relatively
15 large number of points extracted from the first profile is
executed in accordance with the ratio.

9. A profile producing method according to claim
6, wherein said profile obtaining step determines the first
20 profile by correcting an existing third profile defining an
association between the first color data representative of
coordinates on the first color space and the second color
data representative of coordinates on the second color
space in such a manner that a dot gain on each color axis
25 of the first color space is coincident with a dot gain on
each color axis determined in accordance with the color
chart outputted from said output device.

10. A profile producing method according to claim
6, wherein said first color space is defined by color axes
of four colors of cyan C, magenta M, yellow Y and black K,
5 and

said color association definition obtaining step
adopts, as said color chart, a color chart composed of
color patches corresponding to coordinate points not less
than three points, which are designated on each axis
10 coupling vertexes with one another of a cubic area capable
of representing a color by said output device, of each sub-
space where the first color space is divided into a
plurality of sub-spaces defined by color axes of three
colors of C, M, Y, which are associated with a plurality of
15 discrete coordinate points on a color axis of K color,
respectively, and causes said output device to output said
color chart.

11. A profile producing apparatus for producing a
20 profile defining an association between a first color data
representative of coordinates on a predetermined first
color space and a second color data representative of
coordinates on a second color space independent of output
devices, for colors appearing on a color image outputted
25 from an output device for outputting the color image in
accordance with image data including the first color data,
said profile producing apparatus comprising:

a color association definition obtaining section
for obtaining a color association definition, in which
distribution of coordinate points is relatively rough,
defining an association between the first color data
5 representative of coordinates on the first color space and
the second color data representative of coordinates on the
second color space;

a profile selection section for selecting a first
profile from among a plurality of profiles, in which
10 distribution of coordinate points is relatively close as
compared with the color association definition obtained in
said color association definition obtaining section,
defining an association between the first color data
representative of coordinates on the first color space and
15 the second color data representative of coordinates on the
second color space; and

a profile producing section for producing a second
profile defining an association between the first color
data representative of coordinates on the first color space
20 and the second color data representative of coordinates on
the second color space, by correcting the first profile
selected in said profile selection in accordance with the
color association definition obtained in said color
association definition obtaining section.

25
12. A profile producing apparatus according to
claim 11, wherein said profile selection section determines

on each of the plurality of profiles a first evaluation value for evaluating a difference between a dot gain quantity of the color association definition obtained in said color association definition obtaining section and a dot gain quantity of one of the plurality of profiles, and selects one of the plurality of profiles, which is smaller in an evaluated difference, as the first profile in accordance with the first evaluation value.

13. A profile producing apparatus according to claim 11, wherein said profile selection section determines on each of the plurality of profiles a second evaluation value for evaluating a distance between coordinate points on the second color space, which are associated with identical coordinates on the first color space in accordance with the color association definition obtained in said color association definition obtaining section and one of the plurality of profiles, and selects one of the plurality of profiles, which is smaller in an evaluated distance, as the first profile in accordance with the second evaluation value.

14. A profile producing apparatus according to claim 11, wherein said profile selection section determines on each of the plurality of profiles a first evaluation value for evaluating a difference between a dot gain quantity of the color association definition obtained in

ABSTRACT OF THE DISCLOSURE

There are disclosed a profile producing method and a profile producing apparatus for producing a profile representative of the association between the colors on a color image and the color data in accordance with which the color image is outputted, in an output device such as a color printer and a printing machine for outputting color images in accordance with image data including color data. From among a plurality of existing profiles (tables), a suitable table is selected in accordance with an evaluation based on dot gains. A new profile is produced in accordance with the selected table and colorimetry data of a color chart involved in small number of patches.

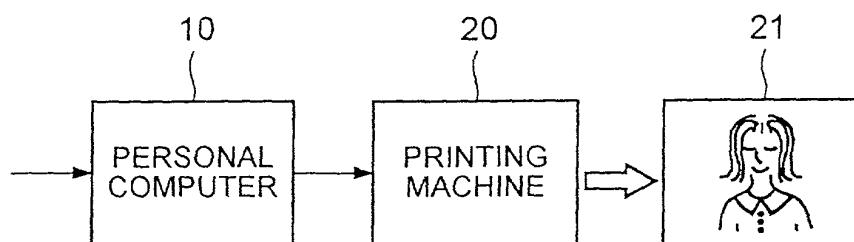


Fig. 1

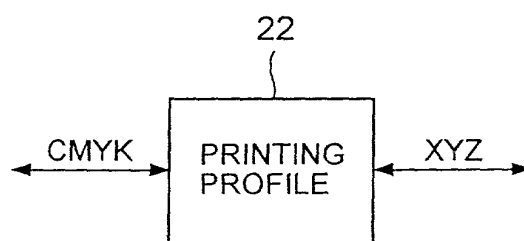


Fig. 2

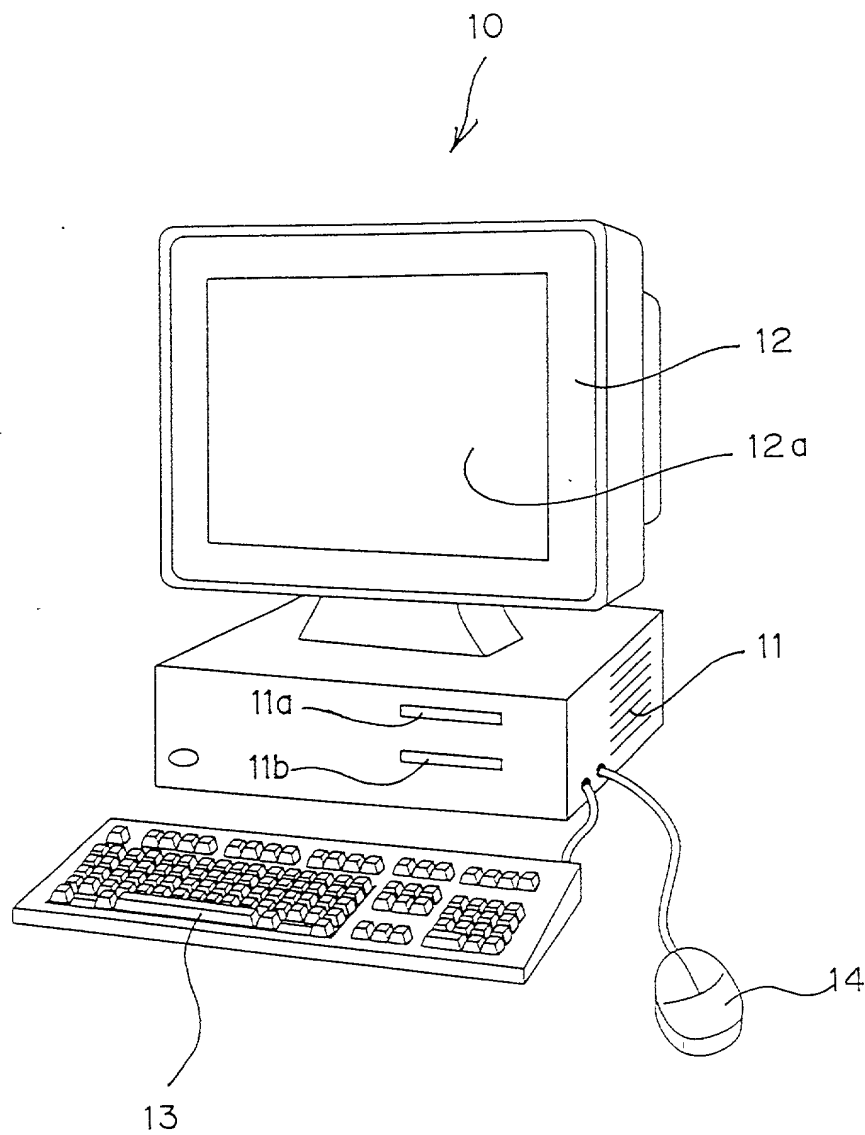


Fig. 3

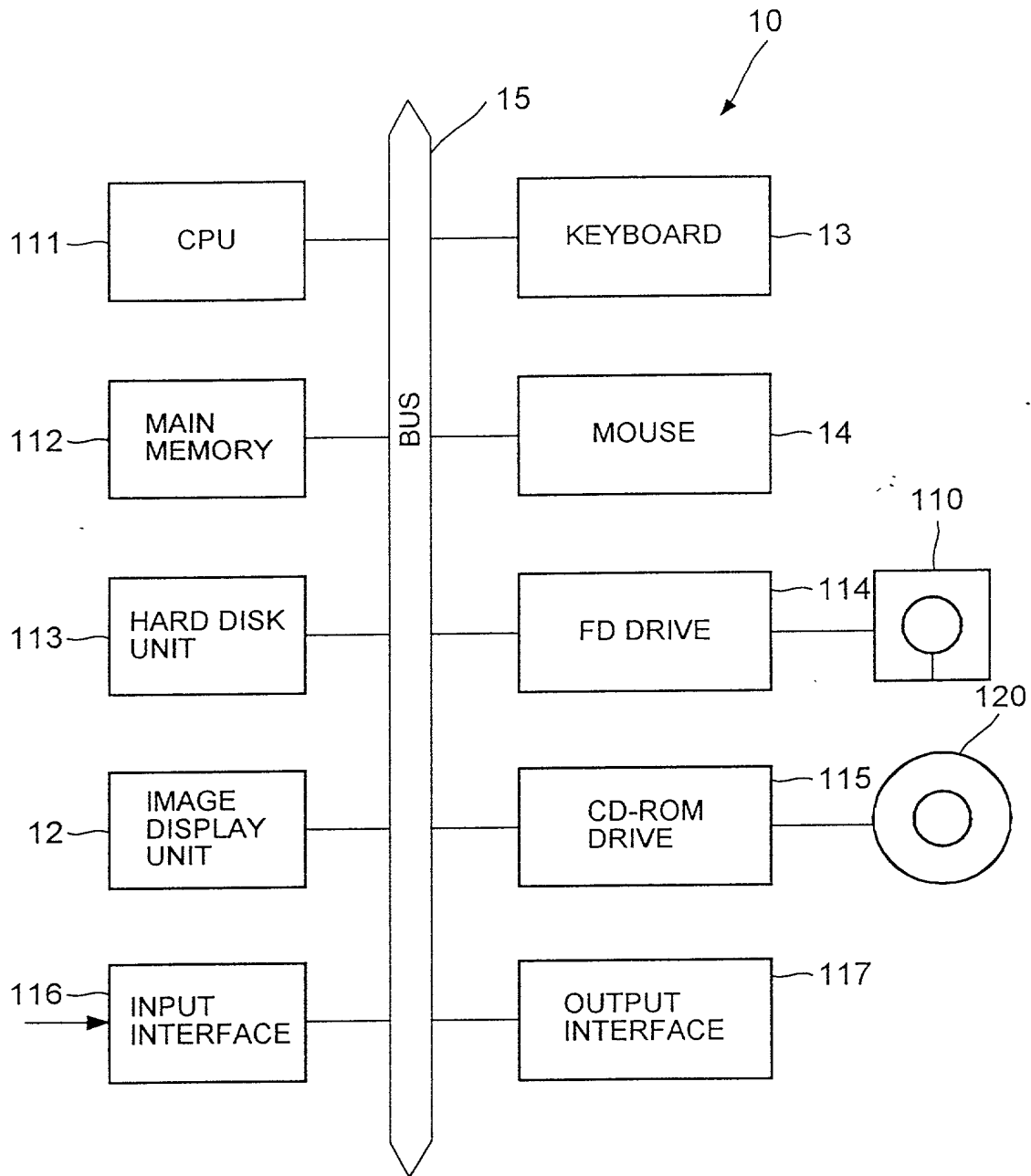


Fig. 4

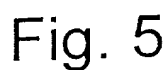
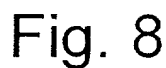
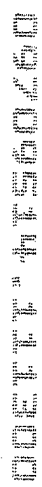


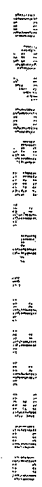
Fig. 5



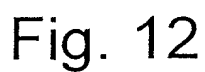


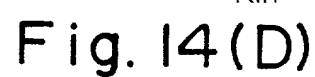
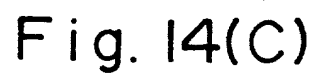
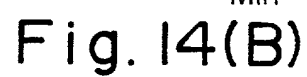
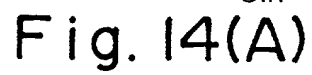
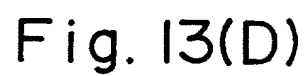
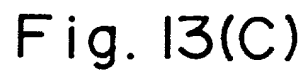
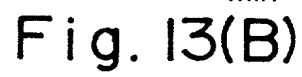
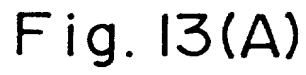


Parameter	Value	Unit
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Initial pH	7.0	
Temperature	25	°C
Time	0, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768, 65536, 131072, 262144, 524288, 1048576, 2097152, 4194304, 8388608, 16777216, 33554432, 67108864, 134217728, 268435456, 536870912, 1073741824, 2147483648, 4294967296, 8589934592, 17179869184, 34359738368, 68719476736, 137438953472, 274877906944, 549755813888, 1099511627776, 2199023255552, 4398046511104, 8796093022208, 17592186044416, 35184372088832, 70368744177664, 140737488355328, 281474976710656, 562949953421312, 1125899906842624, 2251799813685248, 4503599627370496, 9007199254740992, 18014398509481984, 36028797018963968, 72057594037927936, 144115188075855872, 288230376151711744, 576460752303423488, 1152921504606846976, 2305843009213693952, 4611686018427387904, 9223372036854775808, 18446744073709551616, 36893488147419103232, 73786976294838206464, 147573952589676412928, 295147905179352825856, 590295810358705651712, 1180591620717411303424, 2361183241434822606848, 4722366482869645213696, 9444732965739290427392, 18889465931478580854784, 37778931862957161709568, 75557863725914323419136, 151115727451828646838272, 302231454903657293676544, 604462909807314587353088, 1208925819614629174706176, 2417851639229258349412352, 4835703278458516698824704, 9671406556917033397649408, 19342813113834066795298816, 38685626227668133590597632, 77371252455336267181195264, 154742504910672534362390528, 309485009821345068724781056, 618970019642690137449562112, 1237940039285380274899124224, 2475880078570760549798248448, 4951760157141521099596496896, 9903520314283042199192993792, 19807040628566084398385987584, 39614081257132168796771975168, 79228162514264337593543950336, 158456325028528675187087900672, 316912650057057350374175801344, 633825300114114700748351602688, 1267650600228229401496703205376, 2535301200456458802993406410752, 5070602400912917605986812821504, 10141204801825835211973625643008, 20282409603651670423947251286016, 40564819207303340847894502572032, 81129638414606681695789005144064, 162259276829213363391578010288128, 324518553658426726783156020576256, 649037107316853453566312041152512, 1298074214633706907132624082305024, 2596148429267413814265248164610048, 5192296858534827628530496329220096, 10384593717069655257060992658440192, 20769187434139310514121985316880384, 41538374868278621028243970633760768, 83076749736557242056487941267521536, 166153499473114484112975882535043072, 332306998946228968225951765070086144, 664613997892457936451903530140172288, 1329227995784915872903807060280344576, 2658455991569831745807614120560689152, 5316911983139663491615228241121378304, 10633823966279326983230456482242756608, 21267647932558653966460912964485513216, 42535295865117307932921825928971026432, 85070591730234615865843651857942052864, 170141183460469231731687303715884105728, 340282366920938463463374607431768211456, 680564733841876926926749214863536422912, 1361129467683753853853498429727072845824, 2722258935367507707706996859454145691648, 5444517870735015415413993718908291383296, 10889035741470030830827987437816582766592, 21778071482940061661655974875633165533184, 43556142965880123323311949751266331066368, 87112285931760246646623899502532662132736, 174224571863520493293247799005065324265472, 348449143727040986586495598010130648530944, 696898287454081973172991196020261297061888, 1393796574908163946345982392040522594123776, 2787593149816327892691964784081045188247552, 5575186299632655785383929568162090376495104, 11150372599265311570767859136324180752990208, 22300745198530623141535718272648361505980416, 44601490397061246283071436545296723011960832, 89202980794122492566142873090593446023921664, 178405961588244985132285746181186892047843328, 356811923176489970264571492362373784095686656, 713623846352979940529142984724747568191373312, 1427247692705959881058285969449495136382746624, 2854495385411919762116571938898990272765493248, 5708990770823839524233143877797980545530986496, 11417981541647679048466287755595961091061972992, 2283596308329	



Parameter	Value	Unit
Initial concentration	1.0	g/L
Initial pH	7.0	
Temperature	25	°C
Time	0, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768, 65536, 131072, 262144, 524288, 1048576, 2097152, 4194304, 8388608, 16777216, 33554432, 67108864, 134217728, 268435456, 536870912, 1073741824, 2147483648, 4294967296, 8589934592, 17179869184, 34359738368, 68719476736, 137438953472, 274877906944, 549755813888, 1099511627776, 2199023255552, 4398046511104, 8796093022208, 17592186044416, 35184372088832, 70368744177664, 140737488355328, 281474976710656, 562949953421312, 1125899906842624, 2251799813685248, 4503599627370496, 9007199254740992, 18014398509481984, 36028797018963968, 72057594037927936, 144115188075855872, 288230376151711744, 576460752303423488, 1152921504606846976, 2305843009213693952, 4611686018427387904, 9223372036854775808, 18446744073709551616, 36893488147419103232, 73786976294838206464, 147573952589676412928, 295147905179352825856, 590295810358705651712, 1180591620717411303424, 2361183241434822606848, 4722366482869645213696, 9444732965739290427392, 18889465931478580854784, 37778931862957161709568, 75557863725914323419136, 151115727451828646838272, 302231454903657293676544, 604462909807314587353088, 1208925819614629174706176, 2417851639229258349412352, 4835703278458516698824704, 9671406556917033397649408, 19342813113834066795298816, 38685626227668133590597632, 77371252455336267181195264, 154742504910672534362390528, 309485009821345068724781056, 618970019642690137449562112, 1237940039285380274899124224, 2475880078570760549798248448, 4951760157141521099596496896, 9903520314283042199192993792, 19807040628566084398385987584, 39614081257132168796771975168, 79228162514264337593543950336, 158456325028528675187087900672, 316912650057057350374175801344, 633825300114114700748351602688, 1267650600228229401496703205376, 2535301200456458802993406410752, 5070602400912917605986812821504, 10141204801825835211973625643008, 20282409603651670423947251286016, 40564819207303340847894502572032, 81129638414606681695789005144064, 162259276829213363391578010288128, 324518553658426726783156020576256, 649037107316853453566312041152512, 1298074214633706907132624082305024, 2596148429267413814265248164610048, 5192296858534827628530496329220096, 10384593717069655257060992658440192, 20769187434139310514121985316880384, 41538374868278621028243970633760768, 83076749736557242056487941267521536, 166153499473114484112975882535043072, 332306998946228968225951765070086144, 664613997892457936451903530140172288, 1329227995784915872903807060280344576, 2658455991569831745807614120560689152, 5316911983139663491615228241121378304, 10633823966279326983230456482242756608, 21267647932558653966460912964485513216, 42535295865117307932921825928971026432, 85070591730234615865843651857942052864, 170141183460469231731687303715884105728, 340282366920938463463374607431768211456, 680564733841876926926749214863536422912, 1361129467683753853853498429727072845824, 2722258935367507707706996859454145691648, 5444517870735015415413993718908291383296, 10889035741470030830827987437816582766592, 21778071482940061661655974875633165533184, 43556142965880123323311949751266331066368, 87112285931760246646623899502532662132736, 174224571863520493293247799005065324265472, 348449143727040986586495598010130648530944, 696898287454081973172991196020261297061888, 1393796574908163946345982392040522594123776, 2787593149816327892691964784081045188247552, 5575186299632655785383929568162090376495104, 11150372599265311570767859136324180752990208, 22300745198530623141535718272648361505980416, 44601490397061246283071436545296723011960832, 89202980794122492566142873090593446023921664, 178405961588244985132285746181186892047843328, 356811923176489970264571492362373784095686656, 713623846352979940529142984724747568191373312, 1427247692705959881058285969449495136382746624, 2854495385411919762116571938898990272765493248, 5708990770823839524233143877797980545530986496, 11417981541647679048466287755595961091061972992, 2283596308329	





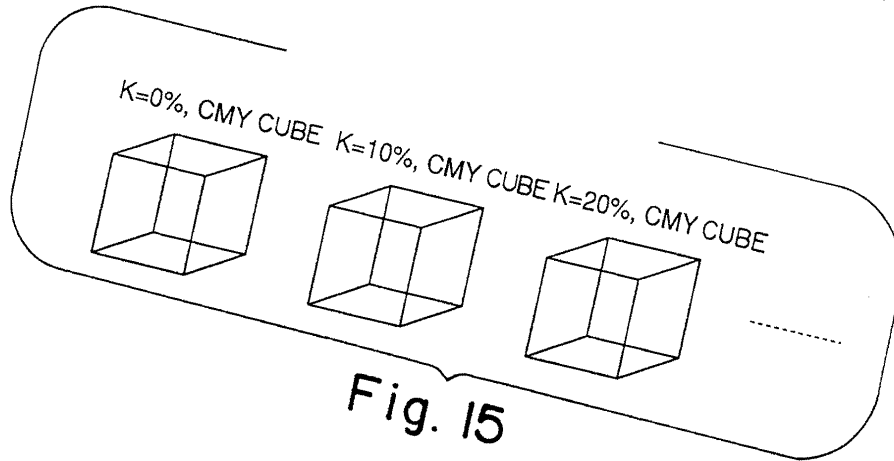


Fig. 15

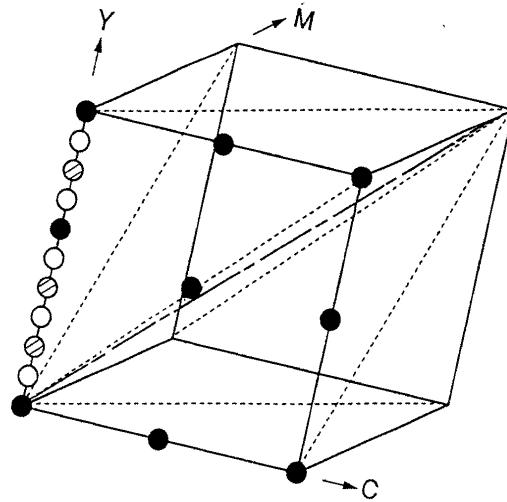


Fig. 16

Color Method

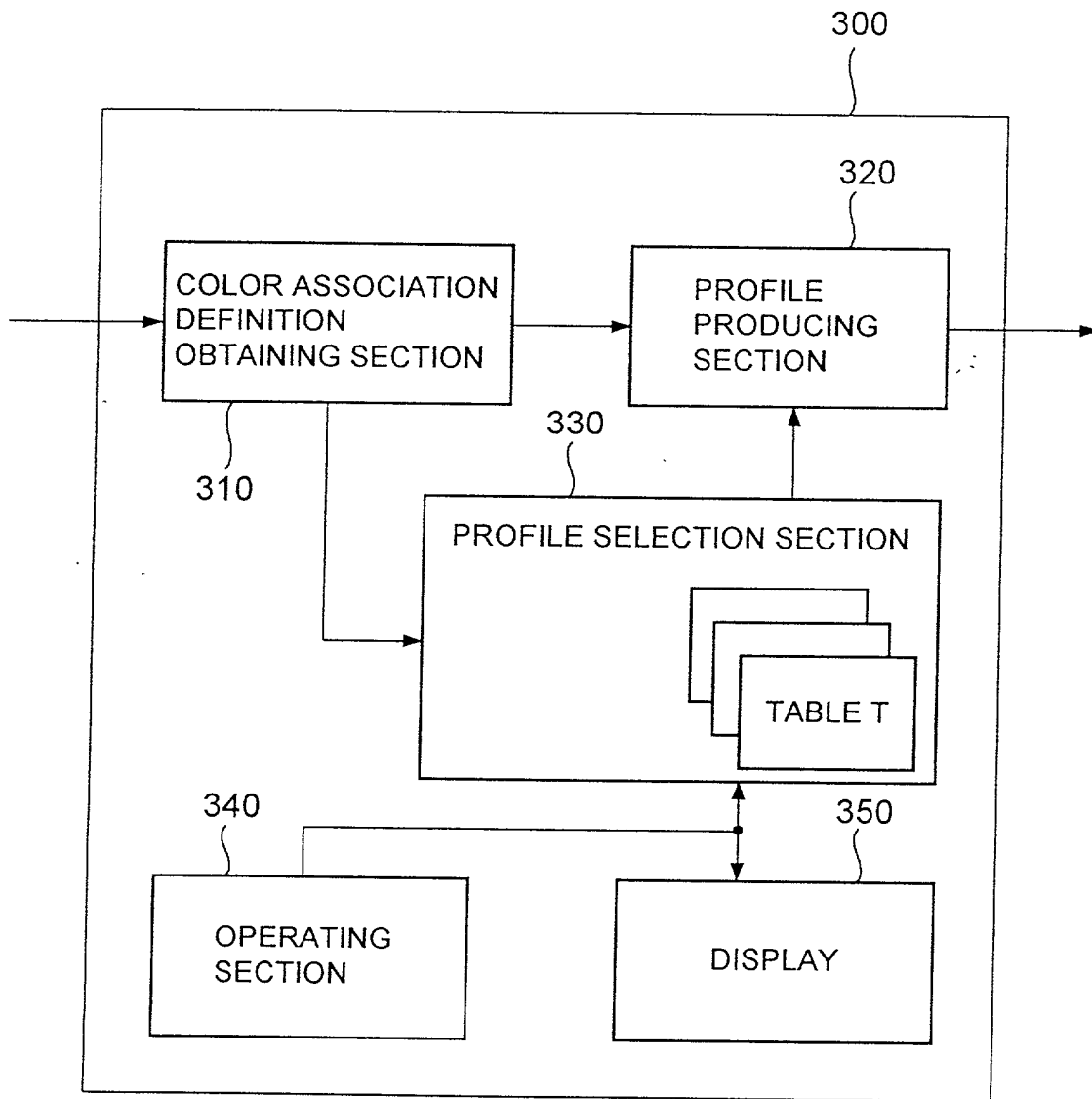


Fig. 17

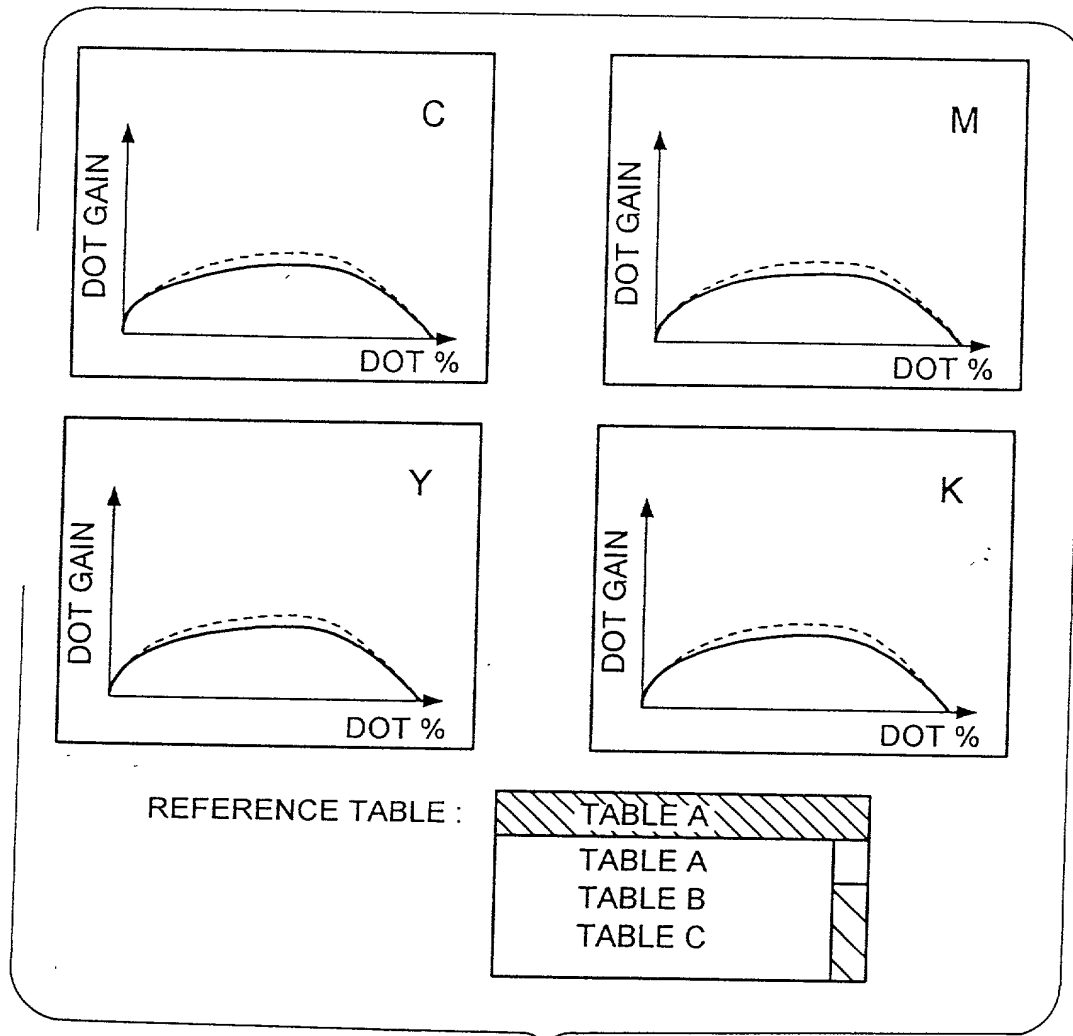


Fig. 18

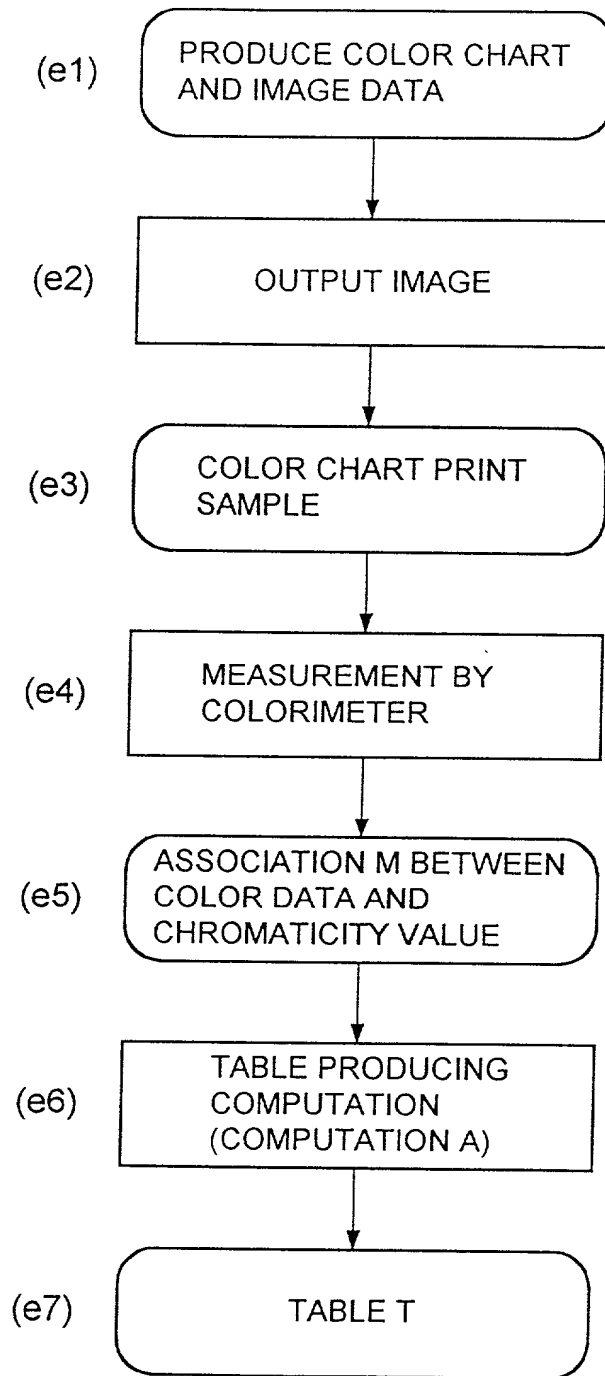


Fig. 19

Declaration and Power of Attorney for Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name,

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者(下記の氏名が一つの場合)もしくは最初かつ共同発明者であると(下記の名称が複数の場合)信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

PROFILE PRODUCING METHOD AND PROFILE PRODUCING

APPARATUS

上記発明の明細書(下記の欄でX印がついていない場合は、本書に添付)は、

the specification of which is attached hereto unless the following box is checked:

☐ ____月 ____日に提出され、米国出願番号または特許協定条約

☐ was filed on _____
as United States Application Number or
PCT International Application Number

国際出願番号を _____ とし、

_____ and was amended on

(該当する場合) _____ に訂正されました。

_____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Japanese Language Declaration

(日本語宣言書)

私は、米国法典第35編第119条(a)-(d)項又は第365条(b)項に基づき下記の、米国以外の国の少なくとも一カ国を指定している特許協力条約第365条(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Applications

外国での先行出願

Priority Not Claimed

優先権主張なし

Hei.11-320680	Japan
(Number)	(Country)
(番号)	(国名)
Hei.11-320683	Japan
(Number)	(Country)
(番号)	(国名)
(Number)	(Country)
(番号)	(国名)

11/November/1999	<input type="checkbox"/>
(Day/Month/Year Filed)	
(出願年月日)	
11/November/1999	<input type="checkbox"/>
(Day/Month/Year Filed)	
(出願年月日)	
(Day/Month/Year Filed)	<input type="checkbox"/>
(出願年月日)	

私は、第35編米国法典119条(e)項に基づいて下記の米国特許出願規定に記載された権利をここに主張致します。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)	(Filing Date)
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(Application No.)	(Filing Date)
(出願番号)	(出願日)

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(Application No.)	(Filing Date)
(出願番号)	(出願日)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

(Application No.)	(Filing Date)
(出願番号)	(出願日)

(Status: Patented, Pending, Abandoned)
(現況: 特許許可済、係属中、放棄済)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration

(日本語宣言書)

委任状：私は、下記の発明者として、本出願に関する一切の手続きを米国特許商標局に対して遂行する弁理士又は代理人として、下記のものを指名致します。(弁護士、又は代理人の氏名及び登録番号を明記のこと)

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